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AN OBSERVATION ON A NEW TYPE OF DISTORTION IN NUCLEAR EMULSIONS.*

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ABSTRACT. An event demonstrating the correlation between spurious scattering and the distortion peculiar to pellicles is described. It is shown that the origin of distortion is non-planarity of the pellicle rather than differential shear as generally understood.

INTRODUCTION

In recent years considerable attention has been paid to the presence of spurious scattering in nuclear emulsions. From an earlier investigation on the causes of spurious scattering (Aditya *et al* 1961, 1963) and subsequent work (Aditya 1962) it became abundantly clear that the origin of spurious scattering lay in the peculiar type of distortion present in emulsion pellicles as a result of their flexibility. In recent works (Aditya and Puri, 1964; Aditya 1964) we have described the characteristics of this distortion and methods of its measurement.

During the course of these investigations measurements were made on a high energy event initiated by cosmic radiation, the very star which had been used by Biswas *et al* (1955) to describe the peculiar nature of spurious scattering; the origin of spurious scattering was not investigated by them. Our measurements have allowed an interpretation of the event in terms of the distortion investigated by us. The analysis is very revealing and is described in the present note.

THE EVENT

A high energy heavy primary nucleus (energy per nucleon $\sim 2\times 10^{10}$eV) traversing a stack of stripped emulsions entered at the surface-stuck-to-glass of a pellicle. At a few microns within the pellicle the heavy primary underwent a fragmentation into six narrowly collimated α-particles. Soon after one of the α-particles produced a second interaction. The collimated beam of five α-particles, followed through the pellicle, was found to leave again at the same face of of the pellicle at which the primary had entered. The maximum depth to which an α-particle went into the pellicle was $\sim 70\mu m$, measured in terms of original

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thickness assumed to be $600\mu m$. The tracks had experienced, obviously, some sort of a severe distortion in the depth direction.

Coordinate measurements on the z and y coordinates of the 5α-particles have been made at $500\mu m$ interval on the x-axis, along which the event was aligned. These have been plotted in Figs. 1. and 2, for the depth and projected plane respectively.

From the plot in depth ($1-a$), the nature of distortion has been obtained by superimposition (1—b), thereby yielding the contour common to all tracks ($1-c$). The contour obtained by the method of algebraic mean (Aditya 1964) has been found to be similar to that shown here. Since the deviations due to multiple

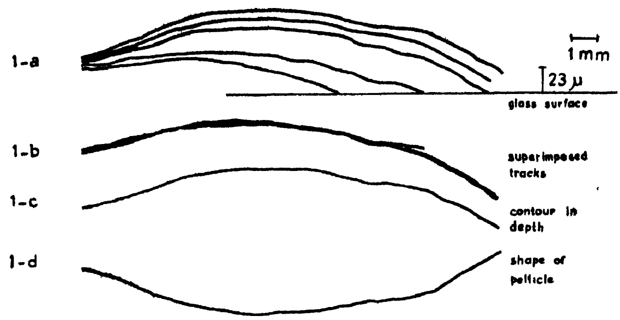

Fig. 1. Profile in depth.

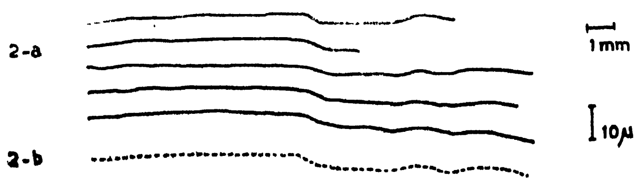

Fig. 2. Profile in projection.

scattering are random there could be no component of scattering in the common contour. Moreover the true scattering is negligibly small and the common contour should be a straight line in the absence of any distortion. It is evident that the contour $1-d$, which is a mirror image of the contour $1-c$, represents the shape of the lower surface of the pellicle, or that of the pellicle as a whole if the thickness is assumed to be uniform. The pellicle was thus not plane at the time of exposure.

This event is particularly favourable since it has been possible to locate the source of the dislocation in depth. The pellicle formed part of a stack, described by Daniel *et al* (1954), in which an $18\mu m$ thick nylon-thread grid, irradiated with pollonium, had been used to mark emulsions for pellicle alignment. The position of the threads as seen in the two sections, elevation and plan, are shown in Fig. 3(a) and (b), respectively. It is clear that the shape of the pellice as derived at 1 – *d*, has resulted from the presence of the marking grid between pellicles. The two sets of grids have so pressed the pellicle that a cup has been formed. It was pointed out also by Daniel *et al* (1954) that the gap height, measured experimentally by following tracks, varies from $25\mu m$ to $35\mu m$ within the stack pellicles, which means that the pellicles were non-plane to the extent indicated by them and is substantiated by our measurements.

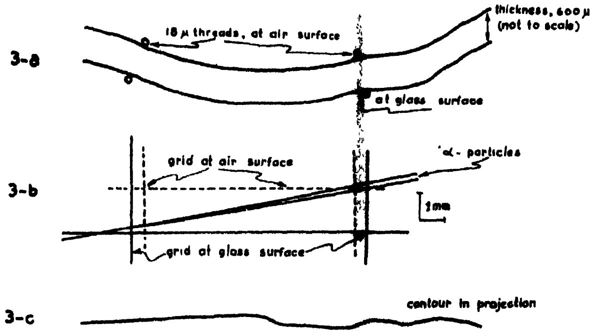

Fig. 3. The scale of (a) is same as in Fig. 1, and of (c) same as in Fig. 2.

The influence of this type of distortion on the shape of the tracks as seen in the projected plane may now be considered. From the plot, in projection, of the α-particles Fig. (2a), the common contour 2 – *b* has been obtained after superimposition. The contour is highly complicated and has no resemblance with the conventional *C* or *S*-shape distortion, which one may normally expect. This contour is reproduced at the bottom of Fig 3 to let a comparison be made with the shape of the pellicle as referred to the position of the grid theads. A point to point correspondence is apparent.

DISCUSSION

The nature and origin of distortion described above is different from that conventionally understood, viz., due to differential shear between various layers of emulsion. A large number of investigations (Cosyns *et al*, 1950; Major, 1952; Apostolakis *et al*, 1957) have been devoted to the determination of this type of distortion, on account of which a straight track is assumed to take a *C*-shape or at worst an *S*-shape. Measurements are conventionally made on fast dipping tracks. The distortion described in this work is not due to differential shear. In the region of emulsion containing this event, for example, Biswas *et al* found the distortion determined by conventional methods to be moderate, (50 covans). We have, instead, shown the distortion to be severe; this is not astonishing because a different mechanism has been considered as the origin and a different method used for the determination of its magnitude.

The correlation between this distortion and the level of spurious scattering will now be demonstrated. The contribution of distortion to the mean second difference, $\overline{D}_d$ (for definition see Aditya 1962) and $\overline{D}_{ss}$ (as obtained by conventional methods) are tabulated in Table. 1, for different sections of the tracks,

TABLE I

Section	Cell length	$\overline{D}_{ss}$ (μ m)	$\overline{D}_d$ (μm)	$\overline{D}_{ss}/\overline{D}_d$
First cm	500μ m	0.245	0.20	1.23
	1000μ m	0.375	0.21	1.78
Second cm	500μ m	0.865	0.58	1.49
	1000μ m	1.06	1.5	0.71
Total Track	500μ m	0 53	0.38	1.39
	1000μ m	0.96	0.91	1.06

as well as for the entire length. It is seen that $\overline{D}_d$ behaves in the same manner as $\overline{D}_{ss}$. Such a correlation has been demonstrated for a wide variety of samples in another work (Aditya *et al.* 1964; Fig. 5).

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